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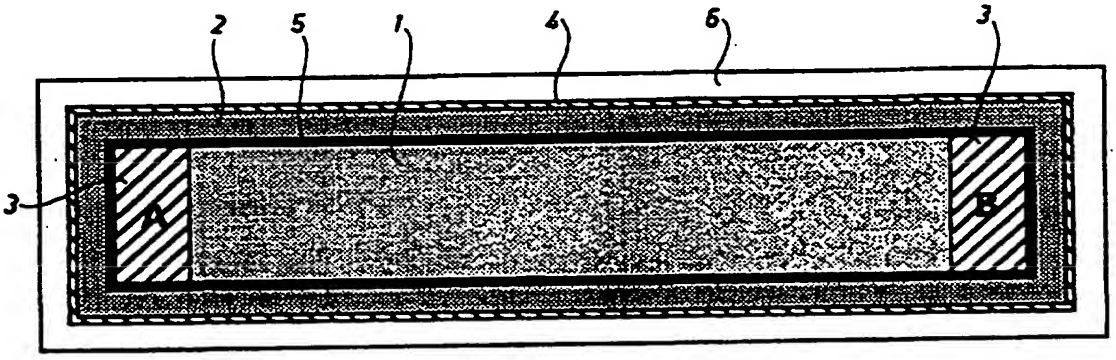
(54) Title: PHOTODETECTOR HAVING AN INTEGRATED FUNCTION FOR ELIMINATION OF THE EFFECTS OF STRAY LIGHT



(57) Abstract

When measuring the position of a lighting point with the aid of position sensitive photodetectors in situations where stray light may occur and may be incident on the inactive area of the detector, the position signal becomes non-linear as well as slow. The purpose of the subject invention is to eliminate the effects of stray lights on the inactive area by doping a further area around the active surface (1). All light incident on the light-absorbing area (2) or the inactive area (6) externally thereof will generate a photoelectric current which is conducted to earth via the light-absorbing area (2) and its associated electrode (4). The position signal from the active area thus will be unaffected by straylight incident on the detector externally of the active area.

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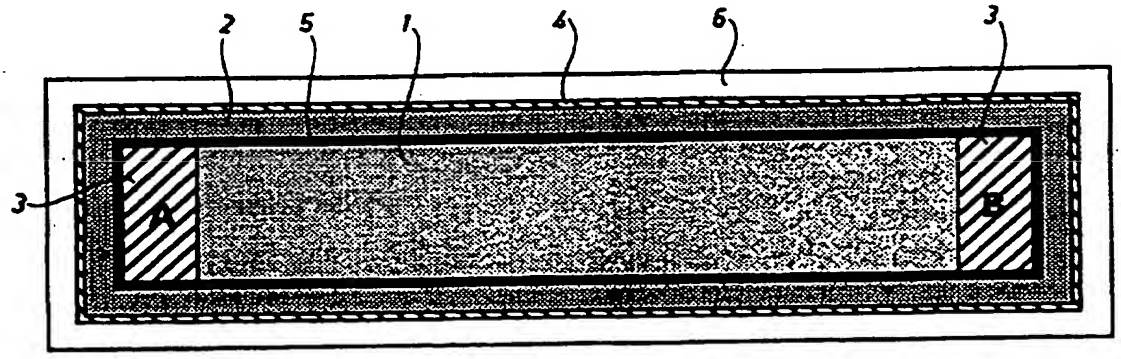

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When measuring the position of a lighting point with the aid of position sensitive photodetectors in situations where stray light may occur and may be incident on the inactive area of the detector, the position signal becomes non-linear as well as slow. The purpose of the subject invention is to eliminate the effects of stray lights on the inactive area by doping a further area around the active surface (1). All light incident on the light-absorbing area (2) or the inactive area (6) externally thereof will generate a photoelectric current which is conducted to earth via the light-absorbing area (2) and its associated electrode (4). The position signal from the active area thus will be unaffected by straylight incident on the detector externally of the active area.

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Photodetector having an integtrated function for elimination of the effects of stray light

The subject invention concerns a device for measuring the position of a lighting spot having an integrated function, in order to handle stray light.

A position-sensitive photodetector, PSD, consists of a semiconductor wafer having a doped active surface with electrodes positioned in mutually opposite sides. The doped active area forms a pn-junction in the semiconductor wafer, and a resistive layer. An incident light beam will generate a photoelectric current which is proportional to the intensity of the incident light. Also, the photoelectric current will be divided in the resistive layer in the two electrodes linearly with the distance from the respective electrode. By comparing the magnitudes of the currents the expression $(I_A-I_B)/(I_A+I_B)$ gives the position of the light beam on the active surface of the detector. (I_A and I_B represent the currents from respectively electrodes A and B). This is true with a high degree of linearity when the lighting point is incident only on the active surface. On the other hand, if light is incident on the semiconductor wafer externally of the active surface (which normally is referred to as the inactive area) a photoelectric current is generated also in this area and is registered in both electrodes. However, these currents are non-linear as well as slow. In other words, the position signal becomes considerably more non-linear and also very much slower. Thus, the possibility of obtaining satisfactory position measurements is impaired and sometimes even made impossible. In cases when the detector is used in applications where stray light occurs, this a considerable problem.

When the stray light emanates from other light sources than the measuring light it is possible, provided that the stray light intensity is within reasonable boundaries, to handle the stray light by means of either electrical or optical filters. An electrical filter is effective by screening off, in the subsequent signal processing, signals emanating from light having a different modulation from that of the measuring light. This method is adopted above all when a modulated light source

having a comparatively high degree of modulation is used, such as 10 kHz, and receiving low-modulated or non-modulated stray light from the environment, such as sun light or fluorescent light etc. Optical bandpass filters operate by only letting through light having wavelengths within a narrow wavelength range. This phenomenon is used when the stray light has a different wavelength from that of the measuring light but otherwise the same modulation (most often non-modulated).

When the stray light emanates from the measuring light itself, owing to reflections in the metal parts of the instrument, for instance, or has a wavelength and a modulation close to that of the measuring light, the problem becomes more difficult to solve. The only way to eliminate the effects of stray light has hitherto been to screen off the stray light from the detector in some way or other. This could be effected in two different ways. Either a diaphragm is placed immediately above the detector or by applying directly on the detector surface a means screening off the light from the inactive area. The diaghragm could either be in the shape of a thin metal foil which is placed immediately ahead of the detector, or a diaghragm which is integrated into the protective glass by means of thin-film technology. This method puts considerably demands on the mounting of the diaghragm, particularly in the case of small-size detectors. In addition, diffraction phenomena may occur in diaghragm opening which thus generates stray light. The other possibility, to apply, in the processing of the very detector, some material screening off the light from the inactive areas, may be effected through vapourization of a metal, gold or aluminium. The disadvantages are that the thickness required in order to obtain absolute screening off of the stray light is not compatible with a normal semiconductor process. In addition, the presence of metal on these surfaces generates problems concerning the electrical properties of the detector. The consequence frequently is high leak currents that and growth thereof may come adrift. An absorbing paint, alternatively an epoxy, may be applied directly on the inactive detector area. This does, however, entail some obvious disadvantages in as much as on the one hand it is difficult to achieve sufficient opacity in the paint/epoxy to prevent passage-through of stray light and on the other the work involved in applying the

paint/epoxy is a pure manual task, possible to carry out only when small quantities are involved, in addition to which the task is difficult to perform with the desired accuracy.

The invention aims at eliminating the effects of a stray light on the inactive area by doping, around the active surface 1, a further area 2 which also forms a pn-junction. This area is connected to earth. All photoelectric current that is generated as a result of light incident on the stray light receiving area 2 will be connected to earth and therefore will not affect the position signal from the active surface 1. Also the photoelectric current formed by the stray light incident on the inactive area 6 outside the stray light receiving area 2 will be handled by the latter area 2 and be conducted to earth via its electrode 4. The active area and the stray light receiving area must be separated by an inactive area 5. When the latter is made as narrow as possible, approximately 10 μm, which is a great deal narrower than is possible with anyone of the methods mentioned above, the signal from this area 5 will have but a minimum effect on the position signal.

The invention is not in any way limited to the geometry illustrated in the accompanying drawing figure but could be applied to optional geometries in 1-dimensional PSDs, 2-dimensional PSDs as well as in photodetectors of various appearences and geometries, such as dual, 4-quadrant, arrays and the like.

CLAIMS

1. A photodetector, characterized in that an area (2) is arranged around the active surface (1) which area prevents stray light from affecting the measuring signal, in that this area (2) consists of a doped area containing a pn-junction, and in that the signal from said area (2) is connected to earth.

2. A device as claimed in claim 1, characterized in that the measurement of the position of a lighting point on the active surface (1) is effected by dividing a photoelectric current generated by light energy via a resistive layer on the active surface (1) and conducting it to oppositely positioned electrodes, a so called position-sensitive photodetector, PSD.

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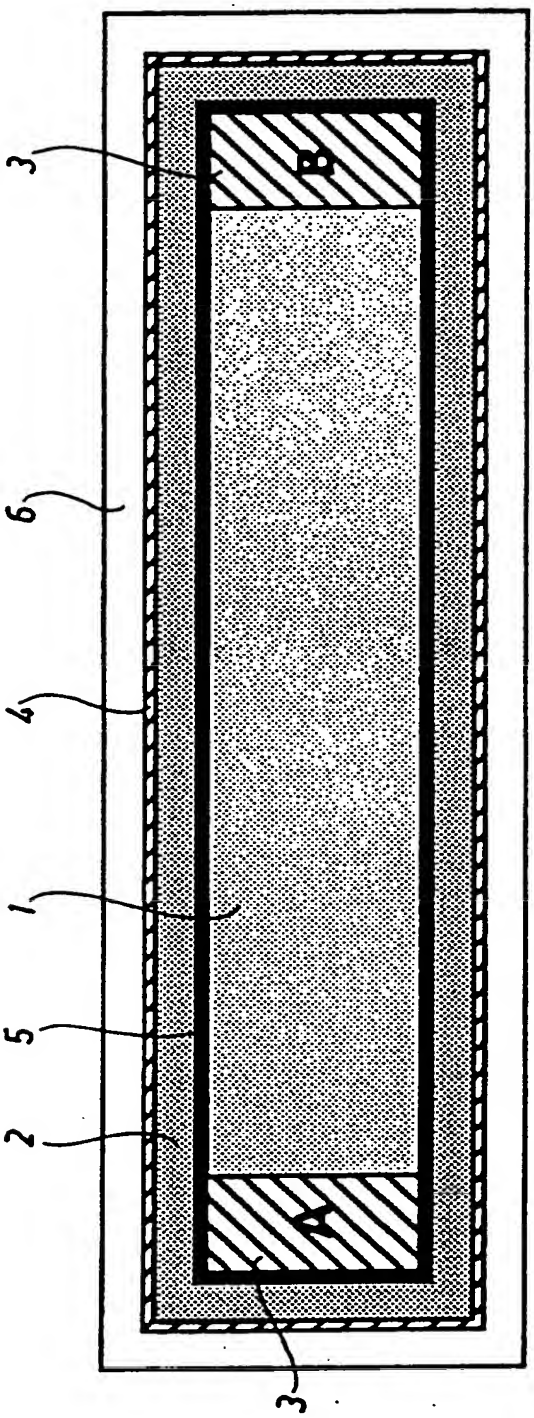

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 95/01021

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G01J 1/42, H01L 31/052
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G01J, H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0243170 A2 (SONY CORPORAITON), 28 October 1987 (28.10.87), column 2, line 28 - column 3, line 31, figure 1, abstract ---	1-2
A	EP 0298458 A2 (CANON KABUSHIKI KAISHA), 11 January 1989 (11.01.89), figure 2B, abstract ---	1-2
A	EP 0545905 A2 (SONY CORPORATION), 9 June 1993 (09.06.93), figure 3B, abstract --- --------	1-2

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT
Information on patent family members

11/12/95

International application No.
PCT/SE 95/01021

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US-A- 4893296	09/01/90